

## PATENT ABSTRACTS OF JAPAN

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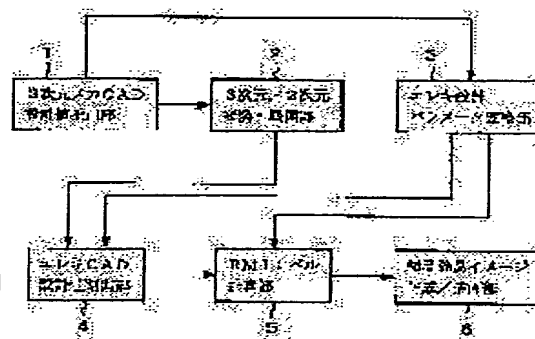
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UNOKO FUJIO**(54) DEVICE AND METHOD FOR SUPPORTING EXAMINATION OF ELECTROMAGNETIC ENVIRONMENT ADAPTABILITY, AND COMPUTER-READABLE RECORDING MEDIUM****(57)Abstract**

**PROBLEM TO BE SOLVED:** To enable both designers of a mechanical system and an electrical system to share mutual design intentions and parameters by using the same design environment from an idea design stage when designing electric and electronic equipment.

**SOLUTION:** A three-dimensional mechanical CAD design value extraction part 1 extracts design information on respective members of an object part of EMC examination from design information of a three-dimensional image of a structure, a three-dimensional/two-dimensional conversion and expansion part 2 expands and displays in a two-dimensional images respective members whose electromagnetic environment adaptability is to be examined according to the design information, and an electrical design parameter conversion part 3 extracts element information regarding electromagnetic influence from the design information; and an electrical CAD design value calculation part 4 finds electromagnetic influence information on the EMS examined part according to the element information, an EMI level calculation part 5 finds judgment information used for the EMC examination of the EMC examined part and improvement index information when the and electromagnetic influence information is not less than a specific reference value, and a product simple image generation/platting part 6 outputs the judgment information and improvement index information.

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CLAIMS

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[Claim(s)]

[Claim 1] A design information extract means to extract the design information of each part material of a part which examines an electromagnetic compatibility from the design information of the structure which consists of two or more members expressed with the three-dimension image, A two-dimensional image expansion display means to develop and display each part material which examines an electromagnetic compatibility based on the design information extracted by this means on a two-dimensional image, An element information extract means to extract the element information concerning electromagnetic effect from the design information extracted by said design information extract means, An electromagnetic effect information acquisition means to search for the electromagnetic effect information on a part that said electromagnetic compatibility is examined based on the element information extracted by this means, When not settled in the reference value with which the decision information with which examination of the electromagnetic compatibility to the part which examines said electromagnetic compatibility based on the electromagnetic effect information searched for by this means is presented, and said electromagnetic effect information were set up beforehand Electromagnetic compatibility examination exchange equipment characterized by having the decision information and an improvement guide information output means to output the electromagnetic compatibility decision information and an improvement guide information acquisition means to search for \*\*\*\* guide information, and the decision information searched for by this means and improvement guide information.

[Claim 2] The design information of each part material of a part which examines an electromagnetic compatibility is extracted from the design information of the structure which consists of two or more members expressed with the three-dimension image. Each part material which examines an electromagnetic compatibility based on the extracted this design information is developed and displayed on a two-dimensional image. The element information concerning electromagnetic effect is extracted from said extracted design information. The electromagnetic effect information on a part that said electromagnetic compatibility is examined based on the extracted this element information is searched for. The improvement guide information when not being settled in the reference value with which the decision information with which examination of the electromagnetic compatibility to the part which examines said electromagnetic compatibility based on this \*\* \*\*\*\* electromagnetic effect information is presented, and said electromagnetic effect information were set up beforehand is searched for. The electromagnetic compatibility examination exchange approach characterized by outputting this \*\* \*\*\*\* decision information and improvement guide information.

[Claim 3] The design information extract function which extracts the design information of each part material of a part which examines an electromagnetic compatibility from the design information of the structure which consists of two or more members expressed with the three-dimension image, The two-dimensional image expansion display function which develops and displays each part material which examines an electromagnetic compatibility based on the design information extracted by this function on a two-dimensional image, The element information extract function which extracts the element information concerning electromagnetic effect from the design information extracted by said design information extract function, The electromagnetic effect information acquisition function to search for the electromagnetic effect information on a part that said electromagnetic compatibility is examined based on the element information extracted by this function, When not settled in the reference value with which the decision information with which examination of the electromagnetic compatibility to the part which examines said electromagnetic compatibility based on the electromagnetic effect information searched for by this function is presented, and said electromagnetic effect information were set up beforehand The electromagnetic compatibility decision information and the improvement guide information acquisition function to search for \*\*\*\* guide information, The record medium which recorded the electromagnetic compatibility examination support program which makes a computer realize the decision information and the improvement guide history output function which outputs the decision information searched for by this function, and improvement guide information and in which computer reading is possible.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the record medium in which the electromagnetic compatibility examination exchange equipment and the electromagnetic compatibility examination exchange approach of offering in order to investigate an electromagnetic compatibility based on the design information of equipment at large [ incorporating an electronic circuitry ], and computer reading are possible.

[0002]

[Description of the Prior Art] In the design process of the conventional electronic electrical machinery and apparatus, based on the demand functionality ability of a machine, the design and the device design were carried out by the initial stage of a design, the structure of an electronic electrical machinery and apparatus and the treatment process of each unit are decided first, and the control system for demonstrating functional ability realizing based on the structure of the electronic electrical machinery and apparatus by the design of such a mechanism system, i.e., an electricity design, was performed. In the above design processes, since cost-constraint, design constraint of a mechanism system, etc. influenced [ since the design of a mechanism system preceded, ] greatly in many cases when the design result was changed by the constraint at the time of an electricity design, and it was going to change the design and the device design, in the electricity design, it was coped with by modification of a control system in many cases.

[0003]

[Problem(s) to be Solved by the Invention] however, the case where the design of an electricity system is changed as mentioned above — radiation — electromagnetism, in order to cope with a noise (Electro Magnetic Interference:EMI) It becomes in the second half of a design process. EMI cure components to the electronic-circuitry substrate and harness of an electricity system It must stop having had to add many members, such as a shielding plate, also to the device section of a mechanism system furthermore in many cases, and there was a problem that the design result optimal on the whole at the time of design process termination was not obtained. Moreover, the information designed using design tools, such as the design information CAD created by the design of a mechanism system, i.e., a mechanism etc. Since parameters, such as a physical dimension value and the quality of the material, are not usually taking the electric design parameter into consideration in a mechanism design environment unlike the parameter treated by the design of an electricity system Since the design information of a mechanism system is not used for the design of an electricity system as it is and the interface of the data of the design tool itself is not established, either, by the mechanism system and the electricity system, it will design in a completely different design environment.

[0004] therefore, it is oral, without using the data which performed the design review and were created with the design tool in the case of transfer of the contents of a design to degree process — it is — must stop having had to check the contents of the design mutually among designers through the drawing, and there was also a problem that where of leakage and a mistake will arise in transfer of the contents of a design, such as modification of a design at degree process, at the time of a design process. Are made in order to solve the above-mentioned technical problem, and the designer of a mechanism system and an electricity system enables it, as for this invention, to share a mutual design intention and a mutual parameter from a design design stage using the same design environment at the time of the design of an electronic electrical machinery and apparatus. While abolishing the mistake of transfer of the contents of a design, and leakage, it enables it to verify quantitatively what kind of effect mutual various constraints in a mechanism system and an electricity system have on a partner's design parameter. It aims at enabling it to inquire so that the design condition of a trade-off may become the balance optimal as a product.

[0005]

[Means for Solving the Problem] In order that this invention may attain the above-mentioned purpose, A design information extract means to extract the design information of each part material of a part which examines an electromagnetic compatibility (EMC) from the design information (physical coordinate data, a dimension value, quality of the material, etc.) of the structure which consists of two or more members (the structure, PCB, a connection harness, cable, etc.) expressed with the three-dimension image, A two-dimensional image expansion display means to develop and display each part material which examines an electromagnetic compatibility based on the design information extracted by the means on a two-dimensional image, Element information concerning the electromagnetic effect from the design information extracted by the above-mentioned design information extract means (for example, with a simple substance metal) An element information extract means to extract the

conductivity of the quality of the material, the thickness of a conductor, magnitude, etc.). An electromagnetic effect information acquisition means to search for the electromagnetic effect information on a part (resonance length, fundamental frequency, harmonic frequency, etc.) that said electromagnetic compatibility is examined based on the element information extracted by the means. With the means It is based on the electromagnetic effect information searched for. The above-mentioned electromagnetic compatibility When not settled in the reference value with which the existence of duplication of decision information harmonic frequency, the level of harmonic frequency, etc. and the above-mentioned electromagnetic effect information with which examination of the electromagnetic compatibility to the part to examine is presented were set up beforehand The electromagnetic compatibility decision information and an improvement guide information acquisition means to search for \*\*\*\*\* guide information (suggestion of modification of the physical relationship of a member, warning, etc.). The decision information and improvement guide information which were searched for by the means are outputted. (It is the display of a message or a graph in specifically changing the foreground color of the member to which it corresponds on a three-dimension image and a two-dimensional image \*\*\*\*) Electromagnetic compatibility examination exchange equipment equipped with the decision information and the improvement guide information output means to carry out is offered.

[0006] Moreover, the design information of each part material of a part which examines an electromagnetic compatibility is extracted from the design information of the structure which consists of two or more members expressed with the three-dimension image. Each part material which examines an electromagnetic compatibility based on the extracted design information is developed and displayed on a two-dimensional image. The element information concerning electromagnetic effect is extracted from the design information by which the extract was carried out [ above-mentioned ]. The electromagnetic effect information on a part that the above-mentioned electromagnetic compatibility is examined based on the extracted element information is searched for. The improvement guide information when not being settled in the reference value with which the decision information and the above-mentioned electromagnetic effect information with which examination of the electromagnetic compatibility to the part which examines the above-mentioned electromagnetic compatibility based on the electromagnetic effect information searched for is presented were set up beforehand is searched for. The electromagnetic compatibility examination exchange approach which outputs the decision information searched for and improvement guide information is offered.

[0007] Furthermore, the design information extract function which extracts the design information of each part material of a part which examines an electromagnetic compatibility from the design information of the structure which consists of two or more members expressed with the three-dimension image, The two-dimensional image expansion display function which develops and displays each part material which examines an electromagnetic compatibility based on the design information extracted by the function on a two-dimensional image, The element information extract function which extracts the element information concerning electromagnetic effect from the design information extracted by the above-mentioned design information extract function, The electromagnetic effect information acquisition function to search for the electromagnetic effect information on a part that the above-mentioned electromagnetic compatibility is examined based on the element information extracted by the function, When not settled in the reference value with which the decision information with which examination of the electromagnetic compatibility to the part which examines the above-mentioned electromagnetic compatibility based on the electromagnetic effect information searched for by the function is presented, and said electromagnetic effect information were set up beforehand The electromagnetic compatibility decision information and the improvement guide information acquisition function to search for \*\*\*\*\* guide information, The record medium which recorded the electromagnetic compatibility examination support program which makes a computer realize the decision information and the improvement guide history output function which outputs the decision information searched for by the function and improvement guide information and in which computer reading is possible is also offered.

[0008]

[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is concretely explained based on a drawing. Drawing 1 is the block diagram showing the configuration of the EMC packaging-design support system which is 1 operation gestalt of the electromagnetic compatibility examination exchange equipment of this invention. (Explanation of the functional description of the EMC packaging-design support system of this operation gestalt) The EMC packaging-design support system of this operation gestalt A common design parameter is prepared by the mechanism system of the structures, such as a copying machine, and the electricity system. It is the system which changes the design information of a mechanism system into the design information of an electricity system, becomes what problem, and meets as EMI level of a product using the conversion result, or calculates a standard, and outputs the new information which can be recognized as a design technical problem of the structure in both a mechanism system and an electricity system. By this system, the output display gestalt in which result decision is possible as a candidate for examination is easily taken for a three dimensions design value by both the mechanism system and the electricity system. Moreover, the activity of trial-and-error of modification of the design information for the mechanism dimension value of the designed structure and EMI level outputting to changing-how coincidence, and making it settled in a certain fixed value of standard is also possible by changing the design value (parameter) of the structure based on the output display gestalt.

[0009] (Explanation of an EMC packaging-design support system configuration) This EMC packaging-design support system is realized by the microcomputer which consists of CPU, a ROM, RAM, etc., and that microcomputer realizes the function of each part shown in drawing 1.

(1) The three-dimension mechanism CAD design value extract section three-dimension mechanism CAD design

value extract section 1 From the three-dimension mechanism CAD design value of the structure Yes, the physical coordinate data and the physical dimension value of \*\*\*\*, the relative-position information between each part articles, the coordinate data of a design design value, and quality-of-the-material information are taken out. the physical coordinate data and the physical dimension value of the physical coordinate data and the physical dimension value of the structure of a part which examines EMC, and PCB global placement, and the connection harness between each PCB — The design information extract information function changed into a data format required for examination of EMC is processed. That is, the function of a design information extract means to extract the design information of each part material of a part which examines an electromagnetic compatibility (EMC) from the design information (physical coordinate data, a dimension value, quality of the material, etc.) of the structure which consists of two or more members (the structure, PCB, a connection harness, cable, etc.) expressed with the three-dimension image as a means to extract the design information of the structure related to an EMC design and a component part is achieved.

[0010] (2) Three-dimension / two-dimensional conversion / expansion section three-dimension / two-dimensional conversion / expansion section 2 reports the physical merit of each part article in order based on the secondary conversion Ruhr as shown below from the data which were taken out by the three-dimension mechanism CAD design value extract section 1, and were changed into the predetermined format, and generates and outputs the two-dimensional expansion image of each part material of the part for EMC examination.

(Two-dimensional conversion Ruhr) Each part article is first separated for each [ which was defined beforehand ] unit of every, and it asks for the data developed two-dimensional in the image which looked at each of that separated unit from the upper part of the structure. In that case, based on a certain fixed criteria, extract selection of connection between the mechanism components which connect every unit, and PCB carried in each units (a screw, a rivet, a sheet metal, welding, etc.), a harness, the cable, etc. is made, and it asks for the data arranged two-dimensional so that the connection distance between each units may become the shortest. Moreover, it asks for the data which express based on each definition also about the connection member from which the point was extracted, and are expressed so that between each unit arranged two-dimensional may be connected. In that case, if attached to a harness and cables, it crawls and asks also for the conditioning in actual equipment which is \*\*\*\*. For example, which frame a harness and cables being bundled where in equipment and being met about and condition information are searched for. And drawing which developed each part article of the part for EMC examination with the two-dimensional image based on the data for which it asked the account of a top is displayed. That is, the function of a two-dimensional image expansion display means to develop and display each part material which examines an electromagnetic compatibility based on the design information extracted by the above-mentioned design information extract means on a two-dimensional image is achieved.

[0011] (3) from the quality of the material of the mechanism components extracted by processing of the three-dimension mechanism CAD design value extract section 1, the structure, a substrate (PCB), a harness, etc., if the electricity design-parameter transducer electricity design-parameter transducer 3 is a conductor and it is a nonmetal (un— a conductor) about conductivity, it will apply specific inductive capacity, it defines the structure of the part for EMC examination, and sets up the conductivity and specific inductive capacity (effective specific inductive capacity) which the quality of the material has, respectively. Moreover, the initial entry on the structure where above-mentioned the definition of each part articles, such as mechanism components extracted by processing of the three-dimension mechanism CAD design value extract section 1, the structure, a substrate (PCB), and a harness, was carried out. The characteristic impedance of the components which each part article crawls and have relation of each direction exception based on physical length information and each quality-of-the-material information, such as the three-dimension-direction of \*\*\*\* and die length, is calculated, and the processing state of the termination is embraced further (by the art of both ends). The resonance length, the fundamental-wave frequency, and harmonic frequency of each part material according to each direction which performs automatic selection of  $\lambda/2$ , and  $\lambda/4$  resonance modes are calculated, and the data is extracted. The conductivity and specific inductive capacity (effective specific inductive capacity) which the quality of the material by which a setup was carried out [ above-mentioned ] on the occasion of the count has are taken into consideration, respectively. That is, the function of an element information extract means to extract element information (for example, a simple substance metal the conductivity of the quality of the material, thickness of a conductor, magnitude, etc.), such as resonance length concerning electromagnetic effect, fundamental frequency, and harmonic frequency, from the design information extracted by the above-mentioned design information extract means as a means to acquire electromagnetic effect information is achieved.

[0012] (4) The electricity CAD design value deduction section electricity CAD design value deduction section 4 The generation source frequency (the frequency of the oscillator currently used by each PCB, frequency of the last stage by which dividing was carried out all over the circuit) which it has for every PCB is made into a fundamental-wave frequency. Indexing of the harmonic frequency (in range from 30MHz to 10GHz), Indexing of a fundamental-wave frequency, the fundamental-wave frequency from indexing of harmonic frequency, the standup of the active device currently further used within PCB, and a falling time amount property, and harmonic frequency based on the clock frequency supplied from other PCBs is performed. About the deduction, the result of the fourier expansion into series of the clock waveform usually used often is used, and the spectrum information is grasped on the assumption that a duty (Duty) 50% clock waveform. That is, the function of an electromagnetic effect information acquisition means to search for the electromagnetic effect information (resonance length, fundamental frequency, harmonic frequency, etc.) on a part that said electromagnetic compatibility is examined based on the element

information extracted by the above-mentioned element information extract means is achieved.

[0013] (5) The EMI level count section EMI level count section 5 It is premised on radiation of the dipole antenna which may set to the processing and is known. The simple equation of the solution method result of the maxwell (MAXWELL) equation under the predetermined conditions shown in several 1 is used. The result of having performed and compounded the vector-operation for every fundamental-wave frequency which extracted the value of each parameter by the above-mentioned processing, and harmonic frequency is sent to the processing process of product simple image generation / drawing section 6. several 1 — radiation field strength [ from a very small dipole antenna ]: — it is the simple type which asks for E (V/m), and frequency:f, current value:i of the frequency, antenna length:L, and measurement distance:R can express. That is, it checks whether there is any wave which resonates among the fundamental wave of the clock frequency currently used by each PCB based on a value as a result of being obtained, respectively in the electricity design parameter transducer 3 and the electricity CAD design value deduction section 4, and a higher harmonic, it calculates as a value of the field strength doubled with measurement in 3m dark room about the frequency of a wave with the possibility of resonance, and the value is outputted to product simple image generation / drawing section 6.

[0014]

[Equation 1]

$$E = 6.3 \times 10^{-7} \times \frac{f \times i \times L}{R}$$

[0015] That is, the function of the electromagnetic compatibility decision information and the improvement guide information acquisition means of asking the improvement guide information (suggestion of modification of the physical relationship of a member, warning, etc.) when not being settled in the reference value with which the decision information (the existence of duplication of harmonic frequency, the level of harmonic frequency, etc.) and the above-mentioned electromagnetic effect information with which examination of the electromagnetic compatibility to the part which examines the above-mentioned electromagnetic compatibility based on the electromagnetic effect information searched for by the above-mentioned electromagnetic effect information acquisition means presents were set up beforehand achieves.

[0016] (6) a product — simple — perform output processing shown in following \*\* - \*\* in image generation / drawing section product simple image generation / drawing section 6.

\*\* The harmonic frequency calculated based on the fundamental-wave frequency used by each PCB calculated by the electricity CAD design value deduction section 4 judges whether there is any duplication for every generation source. For example, it judges whether each harmonic frequency is contained in the range of \*\*120kHz (value of standard) focusing on the frequency. When duplication is detected by the above-mentioned decision, it indicates in which higher harmonic each fundamental wave laps, and the range which the fundamental wave for making the duplication avoid shifts is displayed on coincidence.

\*\* Classify by color and display the harmonic frequency which shows that highest level, and its level for every PCB and connection member on each configuration PCB and every connection member (harness) based on the two-dimensional expansion image by which generation was carried out [ above-mentioned ] with the three-dimension simple image of this structure. Moreover, each frequency spectrum in a frequency shaft is displayed as a 3m dark-room measurement result as the whole structure (for example, machine).

\*\* Arrangement of each PCB, a harness, etc. crawl on those results about, and when it displays that each count result changes into real time to modification of die length, the touch-down approach, and a location and the EMI level is displayed beyond a further predetermined value of standard, judge a connection member [ which configuration PCB and ] are problems, and perform an alarm display. Thus, it can become possible to make a design value change based on the above-mentioned contents of an alarm display, and a user (designer) can raise the design effectiveness of various equipments, such as facsimile apparatus, a copy machine (copying machine), and a machine. That is, the function of the decision information and an improvement guide information output means to output the decision information searched for by the above-mentioned electromagnetic compatibility decision information and improvement guide information acquisition means and improvement guide information is achieved.

[0017] Drawing 2 and drawing 3 are the flow chart Figs. showing the processing in the EMC packaging-design support system shown in drawing 1. Processing of this EMC packaging-design support system incorporates the information relevant to each part into which the three-dimension mechanism CAD design value extract section examines EMC from a three-dimensional-CAD design value at step ("S" shows among drawing) 1 of drawing 2. Similarly the three-dimension mechanism CAD design value extract section acquires the relative-position information between components, a dimension value, magnitude information, such as coordinate data, quality-of-the-material information, etc. at step 2, it changes into a predetermined data format, and an electricity setting parameter transducer distinguishes PCB or mechanism components at step 3. If it is PCB in decision of step 3, it progresses to step 6, and the electricity CAD design value deduction section performs above-mentioned processing, and it progresses to step 9 of drawing 3. If it is mechanism components in decision of step 3, it progresses to step 4 and an electricity design-parameter transducer distinguishes a conductor or a nonconductor, if it is a conductor, it progresses to step 7 and a conductivity setup and a structure definition are performed, and if , it progresses to step 5, and an effective specific-inductive-capacity setup and a structure definition are performed, and it progresses to step 8 shown in drawing 3, respectively.

[0018] Then, three-dimension / two-dimensional conversion / expansion section performs above-mentioned

processing at step 8 of drawing 3. An electricity setting parameter transducer performs above-mentioned electromagnetic element information extract processing at step 9. The EMI level count section performs above-mentioned processing at step 10, product simple image generation / drawing section performs above-mentioned processing at step 11, and it judges whether it is parameter modification by the user at step 12. If it is modification, it progresses to step 14 and judges whether it is modification to PCB, and if it is modification of the parameter to mechanism components, if it is modification of the parameter to return and PCB, it returns to step 8 to step 6 of drawing 2. If it is not parameter modification in decision of step 12, the value which progressed to step 13 and was acquired by above-mentioned processing will judge whether it was settled in the value of standard, and will end this processing.

[0019] It is drawing in which drawing 4's giving an example of a part which examines EMC of the structure in above-mentioned processing to, and showing a slash, and it is drawing in which drawing 5's giving an example of PCB in above-mentioned processing, and mechanism components to, and showing a slash, and drawing 6 is drawing showing an example of the two-dimensional image changed from the three-dimension image of each part article which examines EMC in above-mentioned processing.

[0020]

[Effect of the Invention] As explained above, according to the record medium in which the electromagnetic compatibility examination exchange equipment of this invention, the electromagnetic compatibility examination exchange approach, and computer reading are possible. Since the designer of a mechanism system and an electricity system can share a mutual design intention and a mutual parameter from a design design stage using the same design environment at the time of the design of an electronic electrical machinery and apparatus. While abolishing the mistake of transfer of the contents of a design, and leakage, it is quantitatively verifiable what kind of effect mutual various constraints in a mechanism system and an electricity system have on a partner's design parameter. It can also inquire so that the design condition of a trade-off may become the balance optimal as a product. Therefore, since examination of a design condition etc. can be performed on the preceding paragraph story of a prototype of an electronic electrical machinery and apparatus, the design change after a prototype can be lost, generating of useless cost can be suppressed, and a design period can also be shortened. And a new product can be quickly thrown into a commercial scene by compaction of a design period.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is the block diagram showing the configuration of the EMC packaging-design support system which is 1 operation gestalt of the electromagnetic compatibility examination exchange equipment of this invention.

[Drawing 2] It is the flow chart Fig. showing the processing in the EMC packaging-design support system shown in drawing 1 .

[Drawing 3] It is the flow chart Fig. showing a continuation of the processing shown in drawing 2 .

[Drawing 4] It is drawing in which giving an example of a part which examines EMC of the structure in the processing shown in drawing 2 and drawing 3 to, and showing a slash.

[Drawing 5] It is drawing in which giving an example of PCB in the processing shown in drawing 2 and drawing 3 , and mechanism components to, and showing a slash.

[Drawing 6] It is drawing showing an example of the two-dimensional image changed from the three-dimension image of each part article which examines EMC in the processing shown in drawing 2 and drawing 3 .

[Description of Notations]

- 1:3-dimensional mechanism CAD design value extract section
- 2:3-dimensional / two-dimensional conversion / expansion section
- 3: Electricity design-parameter transducer
- 4: Electricity CAD design value deduction section
- 5: EMI level count section
- 6: Product simple image generation / drawing section

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[Translation done.]



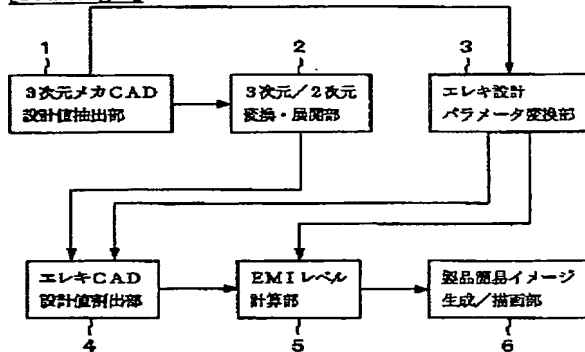
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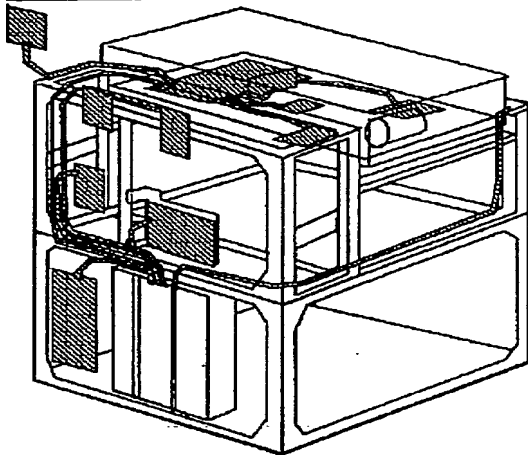
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## DRAWINGS

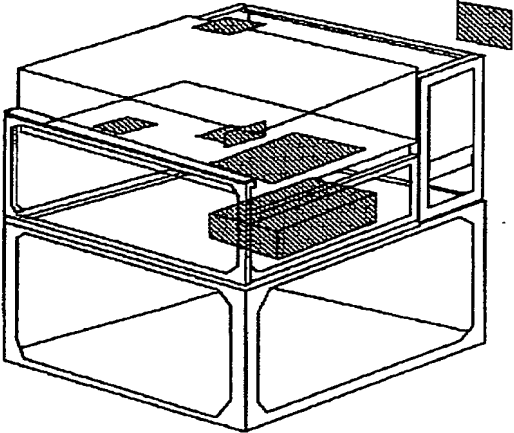
[Drawing 1]



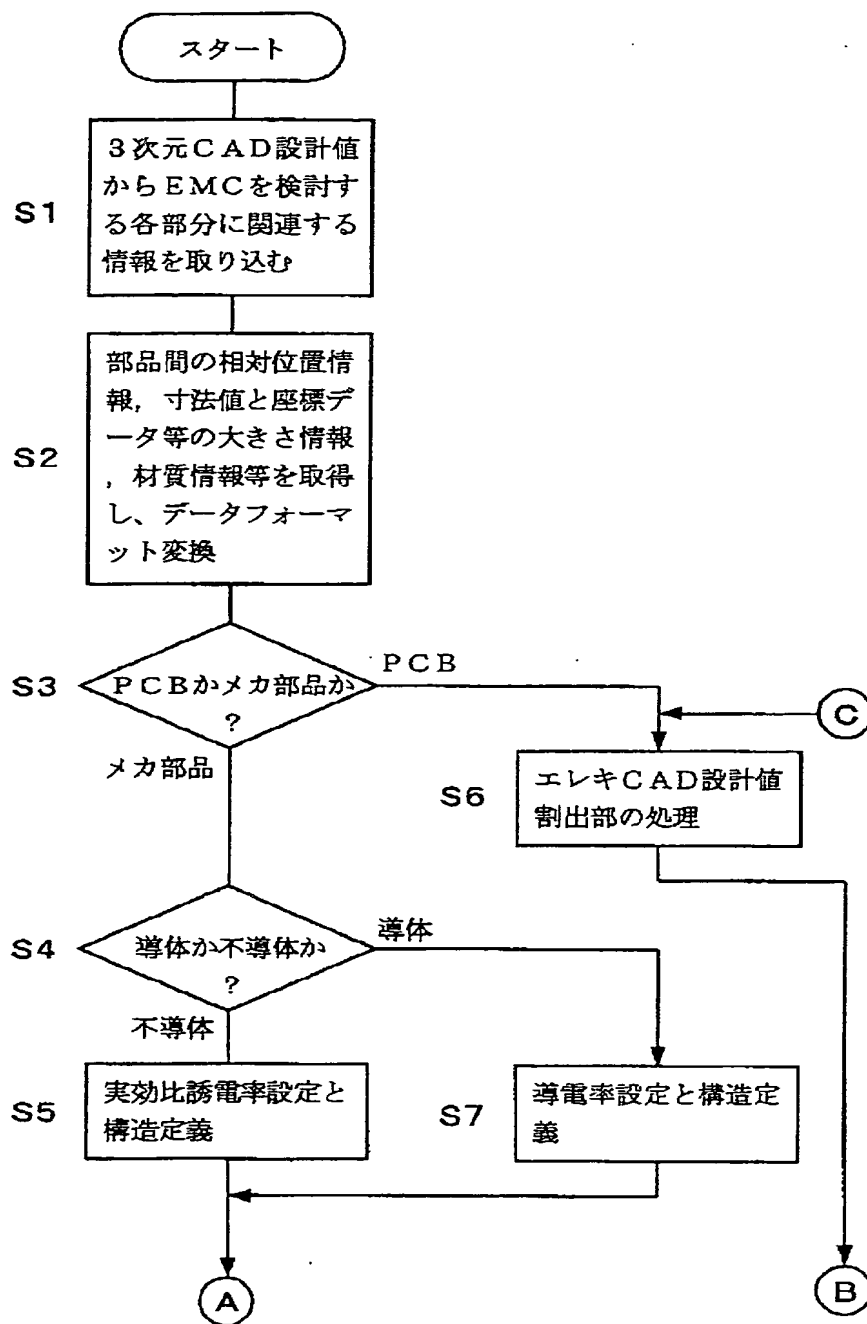
[Drawing 4]



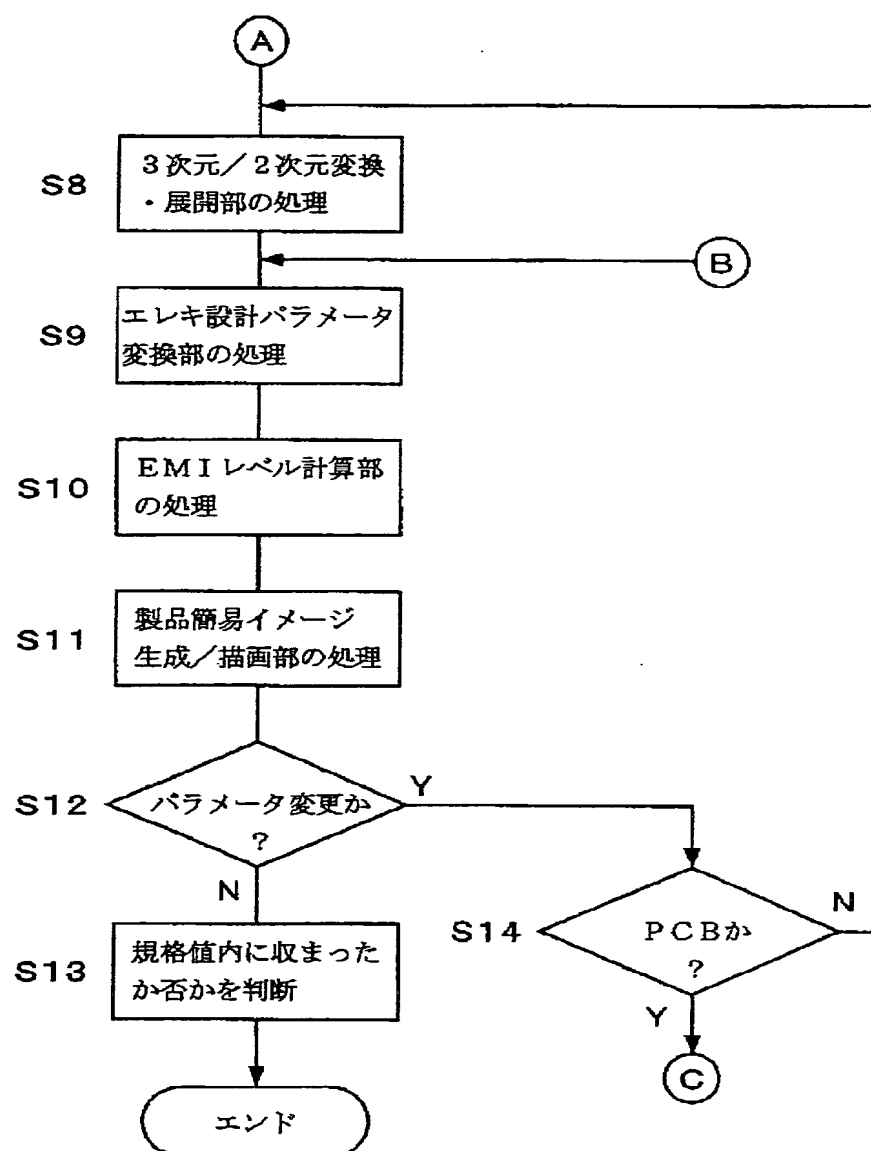
[Drawing 5]



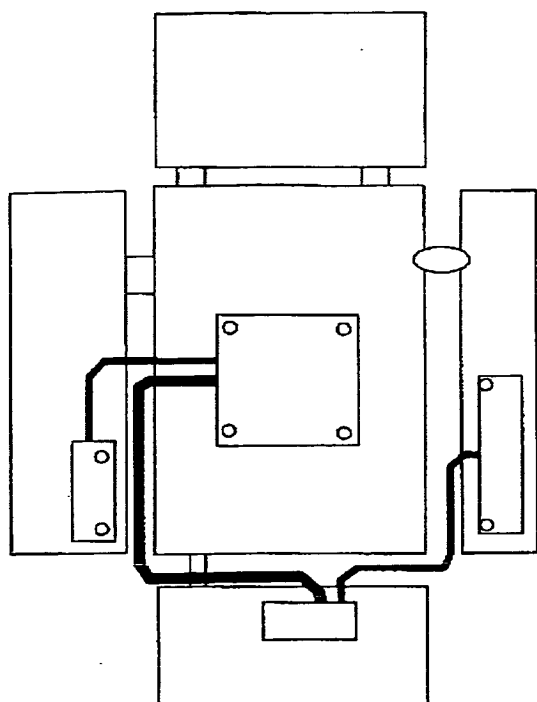
[Drawing 2]



[Drawing 3]



[Drawing 6]



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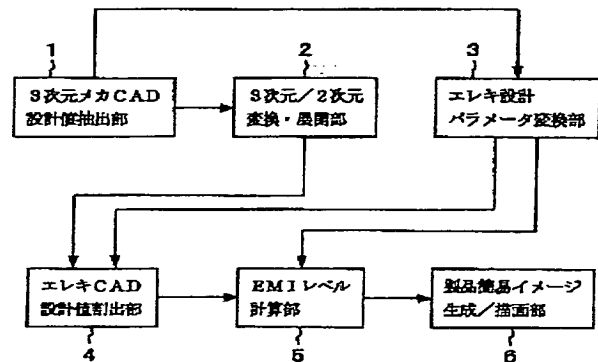
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(54) 【発明の名称】 電磁環境適合性検討支援装置と電磁環境適合性検討支援方法とコンピュータ読み取り可能な記録媒体

(57) 【要約】

【課題】 電子電気機器設計時に構想設計段階からメカ系とエレキ系の設計者が同じ設計環境を使用して互いの設計意図やパラメータを共有できるようにする。

【解決手段】 3次元メカCAD設計値抽出部1は構造物の3次元イメージの設計情報からEMC検討部分の各部材の設計情報を抽出し、3次元/2次元変換・展開部2はその設計情報に基づいて電磁環境適合性を検討する各部材を2次元イメージに展開表示し、エレキ設計パラメータ変換部3はその設計情報から電磁的影響に係わる要素情報を抽出し、エレキCAD設計値割出部4はその要素情報に基づいてEMC検討部分の電磁的影響情報を求め、EMIレベル計算部5はその電磁的影響情報に基づいてEMC検討部分に対するEMC検討に供する判断情報と電磁的影響情報が所定基準値内に収まらないときの改善指針情報を求め、製品簡易イメージ生成/描画部6は上記判断情報と改善指針情報とを出力する。



## 【特許請求の範囲】

【請求項1】 3次元イメージで表された複数個の部材からなる構造物の設計情報から電磁環境適合性を検討する部分の各部材の設計情報を抽出する設計情報抽出手段と、

該手段によって抽出された設計情報に基づいて電磁環境適合性を検討する各部材を2次元イメージに展開して表示する2次元イメージ展開表示手段と、

前記設計情報抽出手段によって抽出された設計情報から電磁的影響に係わる要素情報を抽出する要素情報抽出手段と、

該手段によって抽出された要素情報に基づいて前記電磁環境適合性を検討する部分の電磁的影響情報を求める電磁的影響情報取得手段と、

該手段によって求められた電磁的影響情報に基づいて前記電磁環境適合性を検討する部分に対する電磁環境適合性の検討に供する判断情報と前記電磁的影響情報が予め設定された基準値内に収まらないときの改善指針情報を求める電磁環境適合性判断情報・改善指針情報取得手段と、

該手段によって求められた判断情報と改善指針情報とを出力する判断情報・改善指針情報出力手段とを備えたことを特徴とする電磁環境適合性検討支援装置。

【請求項2】 3次元イメージで表された複数個の部材からなる構造物の設計情報から電磁環境適合性を検討する部分の各部材の設計情報を抽出し、該抽出された設計情報に基づいて電磁環境適合性を検討する各部材を2次元イメージに展開して表示し、前記抽出された設計情報から電磁的影響に係わる要素情報を抽出し、該抽出された要素情報に基づいて前記電磁環境適合性を検討する部分の電磁的影響情報を求め、該求められた電磁的影響情報に基づいて前記電磁環境適合性を検討する部分に対する電磁環境適合性の検討に供する判断情報と前記電磁的影響情報が予め設定された基準値内に収まらないときの改善指針情報を求め、該求められた判断情報と改善指針情報とを出力することを特徴とする電磁環境適合性検討支援方法。

【請求項3】 3次元イメージで表された複数個の部材からなる構造物の設計情報から電磁環境適合性を検討する部分の各部材の設計情報を抽出する設計情報抽出機能と、該機能によって抽出された設計情報に基づいて電磁環境適合性を検討する各部材を2次元イメージに展開して表示する2次元イメージ展開表示機能と、前記設計情報抽出機能によって抽出された設計情報から電磁的影響に係わる要素情報を抽出する要素情報抽出機能と、該機能によって抽出された要素情報に基づいて前記電磁環境適合性を検討する部分の電磁的影響情報を求める電磁的影響情報取得機能と、該機能によって求められた電磁的影響情報に基づいて前記電磁環境適合性を検討する部分に対する電磁環境適合性の検討に供する判断情報と前記

電磁的影響情報が予め設定された基準値内に収まらないときの改善指針情報を求める電磁環境適合性判断情報・改善指針情報取得機能と、該機能によって求められた判断情報と改善指針情報とを出力する判断情報・改善指針情報出力機能とをコンピュータに実現させる電磁環境適合性検討支援プログラムを記録したコンピュータ読み取り可能な記録媒体。

## 【発明の詳細な説明】

【0001】

【発明の属する技術分野】この発明は、電子回路を組み込んだ装置全般の設計情報に基づいて電磁環境適合性を調べるために供する電磁環境適合性検討支援装置と電磁環境適合性検討支援方法とコンピュータ読み取り可能な記録媒体に関する。

【0002】

【従来の技術】従来の電子電気機器の設計プロセスでは、設計の初期段階で機械の要求機能性能に基づいてデザイン、機構設計を実施し、まず電子電気機器の構造や各ユニットの処理プロセスを決めており、そのようなメカ系の設計による電子電気機器の構造に基づいて実現したい機能性能を発揮するための制御系、即ちエレキ設計を行っていた。上述のような設計プロセスでは、メカ系の設計が先行してしまうので、その設計結果をエレキ設計時の制約条件で変更する場合、デザインや機構設計を変えようとするとコスト的な制約やメカ系の設計制約などが大きく影響することが多いので、エレキ設計において制御系の変更に対処することが多かった。

【0003】

【発明が解決しようとする課題】しかしながら、上述のようにエレキ系の設計を変更する場合、放射電磁ノイズ(Electro Magnetic Interference: EMI)の対策を施す為に、設計プロセスの後半になってEMI対策部品がエレキ系の電子回路基板やハーネスに、さらにはメカ系の機構部にもシールド板などの部材を数多く追加しなければならない場合が多く、設計プロセス終了時に全体的に最適な設計結果が得られないという問題があった。また、メカ系の設計で作成された設計情報、つまりメカCAD等の設計ツールを使って設計された情報は、物理的な寸法値、材質などのパラメータがエレキ系の設計で扱うパラメータとは異なり、通常はメカ設計環境では電気的な設計パラメータを考慮していないので、メカ系の設計情報をエレキ系の設計にはそのまま使用していないし、設計ツールそのもののデータのインタフェースも確立されてはいないこともあって、メカ系とエレキ系では全く異なった設計環境で設計することになる。

【0004】したがって、次工程への設計内容の伝達の際には、デザインレビューを行って設計ツールで作成されたデータを用いずに口頭であるいは図面を介して設計者間で設計の内容を互いに確認しなければならなくな

り、設計プロセス時に次工程への設計の変更等の設計内容の伝達に漏れやミスが生じてしまうという問題もあった。この発明は上記の課題を解決するためになされたものであり、電子電気機器の設計時に構想設計段階からメカ系とエレキ系の設計者が同じ設計環境を使用して互いの設計意図やパラメータを共有できるようにし、設計内容の伝達ミスや漏れを無くすと共に、メカ系とエレキ系での互いのいろいろな制約条件が相手の設計パラメータにどのような影響を与えるかを定量的に検証できるようにして、トレードオフの設計条件が製品として最適なバランスになるように検討できるようにすることを目的とする。

#### 【0005】

【課題を解決するための手段】この発明は上記の目的を達成するため、3次元イメージで表された複数の部材（構造体、PCB、接続ハーネス、ケーブル等）からなる構造物の設計情報（物理的な座標データ、寸法値、材質等）から電磁環境適合性（EMC）を検討する部分の各部材の設計情報を抽出する設計情報抽出手段と、その手段によって抽出された設計情報に基づいて電磁環境適合性を検討する各部材を2次元イメージに展開して表示する2次元イメージ展開表示手段と、上記設計情報抽出手段によって抽出された設計情報から電磁的影響に係わる要素情報（例えば、単体金属では、材質の導電率、導体の厚さ、大きさ等）を抽出する要素情報抽出手段と、その手段によって抽出された要素情報に基づいて前記電磁環境適合性を検討する部分の電磁的影響情報（共振長、基本周波数、高調波周波数等）を求める電磁的影響情報取得手段と、その手段によって求められた電磁的影響情報に基づいて上記電磁環境適合性を検討する部分に対する電磁環境適合性の検討に供する判断情報高調波周波数の重複の有無、高調波周波数のレベル等）と上記電磁的影響情報が予め設定された基準値内に収まらないときの改善指針情報（部材の位置関係の変更の示唆、警告など）を求める電磁環境適合性判断情報・改善指針情報取得手段と、その手段によって求められた判断情報と改善指針情報とを出力（具体的には、3次元イメージと2次元イメージ上の該当する部材の表示色を異ならせたり、メッセージやグラフの表示）する判断情報・改善指針情報出力手段を備えた電磁環境適合性検討支援装置を提供する。

【0006】また、3次元イメージで表された複数の部材からなる構造物の設計情報から電磁環境適合性を検討する部分の各部材の設計情報を抽出し、その抽出された設計情報に基づいて電磁環境適合性を検討する各部材を2次元イメージに展開して表示し、上記抽出された設計情報から電磁的影響に係わる要素情報を抽出し、その抽出された要素情報に基づいて上記電磁環境適合性を検討する部分の電磁的影響情報を求め、その求められた電磁的影響情報に基づいて上記電磁環境適合性を検討する

部分に対する電磁環境適合性の検討に供する判断情報と上記電磁的影響情報が予め設定された基準値内に収まらないときの改善指針情報を求め、その求められた判断情報と改善指針情報とを出力する電磁環境適合性検討支援方法を提供する。

【0007】さらに、3次元イメージで表された複数の部材からなる構造物の設計情報から電磁環境適合性を検討する部分の各部材の設計情報を抽出する設計情報抽出機能と、その機能によって抽出された設計情報に基づいて電磁環境適合性を検討する各部材を2次元イメージに展開して表示する2次元イメージ展開表示機能と、上記設計情報抽出機能によって抽出された設計情報から電磁的影響に係わる要素情報を抽出する要素情報抽出機能と、その機能によって抽出された要素情報に基づいて上記電磁環境適合性を検討する部分の電磁的影響情報を求める電磁的影響情報取得機能と、その機能によって求められた電磁的影響情報に基づいて上記電磁環境適合性を検討する部分に対する電磁環境適合性の検討に供する判断情報と前記電磁的影響情報が予め設定された基準値内に収まらないときの改善指針情報を求める電磁環境適合性判断情報・改善指針情報取得機能と、その機能によって求められた判断情報と改善指針情報とを出力する判断情報・改善指針情報出力機能とをコンピュータに実現させる電磁環境適合性検討支援プログラムを記録したコンピュータ読み取り可能な記録媒体も提供する。

#### 【0008】

【発明の実施の形態】以下、この発明の実施形態を図面に基づいて具体的に説明する。図1は、この発明の電磁環境適合性検討支援装置の一実施形態であるEMC実装設計支援システムの構成を示すブロック図である。

（この実施形態のEMC実装設計支援システムの機能概要の説明）この実施形態のEMC実装設計支援システムは、複写機等の構造物のメカ系、エレキ系で共通の設計パラメータを用意し、メカ系の設計情報をエレキ系の設計情報に変換し、その変換結果を利用して製品のEMIレベルとしてどの程度の問題になりそうか目安を計算し、メカ系とエレキ系の両方において構造物の設計課題として認識可能な新たな情報を出力するシステムである。このシステムでは、三次元的な設計値をメカ系とエレキ系の両方で容易に検討対象として結果判断可能な出力表示形態をとる。また、その出力表示形態に基づいて、構造物の設計値（パラメータ）を変化させることにより、設計した構造物のメカ寸法値、EMIレベルがどのように変化するかも同時に出力し、ある一定の規格値内に収まるようにするための設計情報の変更の試行錯誤の作業も可能である。

【0009】（EMC実装設計支援システム構成の説明）このEMC実装設計支援システムは、CPU、ROM、RAM等からなるマイクロコンピュータによって実現され、そのマイクロコンピュータが図1に示した各部

の機能を実現する。

#### 〔1〕3次元メカCAD設計値抽出部

3次元メカCAD設計値抽出部1は、構造物の3次元メカCAD設計値から、EMCを検討する部分の構造物の物理的な座標データ及び寸法値、PCB概略配置の物理的な座標データ及び寸法値、各PCB間の接続ハーネスはい回しの物理的な座標データ及び寸法値、各部品間の相対位置情報、デザイン設計値の座標データ、材質情報を取り出し、EMCの検討に必要なデータフォーマットに変換する設計情報抽出情報機能の処理を行う。すなわち、EMC設計に関係する構造物、構成部品の設計情報を抽出する手段として、3次元イメージで表された複数の(構造物、PCB、接続ハーネス、ケーブル等の)部材からなる構造物の(物理的な座標データ、寸法値、材質等の)設計情報から電磁環境適合性(EMC)を検討する部分の各部材の設計情報を抽出する設計情報抽出手段の機能を果たす。

#### 〔0010〕(2)3次元/2次元変換・展開部

3次元/2次元変換・展開部2は、3次元メカCAD設計値抽出部1によって取り出されて所定のフォーマットに変換されたデータから以下に示すような2次元変換ルールに基づいて各部品の物理長を並べ直してEMC検討対象の部分の各部材の2次元展開イメージを生成して出力する。

(2次元変換ルール)各部品を予め定義された各ユニット毎にまず分離し、その分離された各ユニットを構造物の上部から見たイメージで2次元的に展開するデータを求める。その際、各ユニット毎を接続するメカ部品(ビス、リベット、板金、溶接など)、各ユニット内に搭載されるPCB間の接続、ハーネス、ケーブル等をある一定の基準に基づいて抽出選択し、各々のユニット間の接続距離が最短になるように2次元的に配置するデータを求める。また、先の抽出された接続部材についてもそれぞれの定義に基づいて表現し、2次元的に配置された各ユニット間を接続するように表現するデータを求める。その際、ハーネス、ケーブル類については実際の装置でのはい回しの条件設定も求める。例えば、ハーネス、ケーブル類を装置内のどこで束ねてどのフレームに沿ってはい回すか等の条件情報を求める。そして、上記求めたデータに基づいてEMC検討対象の部分の各部品を2次元イメージに展開した図を表示する。すなわち、上記設計情報抽出手段によって抽出された設計情報に基づいて電磁環境適合性を検討する各部材を2次元イメージに展開して表示する2次元イメージ展開表示手段の機能を果たす。

#### 〔0011〕(3)エレキ設計パラメータ変換部

エレキ設計パラメータ変換部3は、3次元メカCAD設計値抽出部1の処理によって抽出されたメカ部品、構造物、基板(PCB)、ハーネスなどの材質から導体であれば導電率を、非金属(非導体)であれば比誘電率を当

てはめて、EMC検討対象の部分の構造を定義し、その材質の持つ導電率と比誘電率(実効比誘電率)をそれぞれ設定する。また、3次元メカCAD設計値抽出部1の処理によって抽出されたメカ部品、構造物、基板(PCB)、ハーネスなどの各部品の上記定義された構造上の接続情報と、各部品のはい回しの3次元的な方向、長さ等の物理長情報とそれぞれの材質情報とに基づいて各方向別の繋がりのある部品の特性インピーダンスを計算し、さらにその終端の処理状態に応じて(両端の処理方法によって、 $\lambda/2$ 、 $\lambda/4$ 共振モードの自動選択を行う)各方向別の各部材の共振長、基本波周波数及び高調波周波数を計算して、そのデータを抽出する。その計算の際に上記設定された材質の持つ導電率と比誘電率(実効比誘電率)をそれぞれ考慮する。すなわち、電磁的影響情報を取得する手段として、上記設計情報抽出手段によって抽出された設計情報から電磁的影響に係わる共振長、基本波周波数、高調波周波数等の要素情報(例えば、単体金属では、材質の導電率、導体の厚さ、大きさ等)を抽出する要素情報抽出手段の機能を果たす。

#### 〔0012〕(4)エレキCAD設計値割出部

エレキCAD設計値割出部4は、各PCB毎に有する発生源周波数(各PCBで使用されている発振器の周波数、その回路中で分周された最終段の周波数)を基本波周波数として、その高調波周波数(30MHzから10GHzまでの範囲で)の割り出しと、他のPCBから供給されるクロック周波数に基づく基本波周波数と高調波周波数の割り出し、更に、PCB内で使用している能動デバイスの立ち上がり、立ち下がり時間特性からの基本波周波数と高調波周波数の割り出しを行う。その割り出しについては、通常よく使われるクロック波形のフーリエ級数展開の結果を使用し、デューティ(Duty)50%のクロック波形を前提にして、そのスペクトラム情報を把握しておく。すなわち、上記要素情報抽出手段によって抽出された要素情報に基づいて前記電磁環境適合性を検討する部分の(共振長、基本波周波数、高調波周波数等の)電磁的影響情報を求める電磁的影響情報取得手段の機能を果たす。

#### 〔0013〕(5)EMIレベル計算部

EMIレベル計算部5は、その処理において良く知られているダイポールアンテナの放射を前提にしており、数1に示す所定の条件下でのマックスウェル(MAXWELL)方程式の解法結果の簡易式を使用し、各々のパラメータの値を上記処理で抽出した各基本波周波数、各高調波周波数毎にベクトル的な演算を施して合成した結果を製品簡易イメージ生成/描画部6の処理過程へ送る。数1は微小ダイポールアンテナからの放射電界強度:  $E$  (V/m)を求める簡易式であり、周波数:  $f$ 、その周波数の電流値:  $i$ 、アンテナ長:  $L$ 、測定距離:  $R$ によって表すことができる。つまり、エレキ設計パラメータ変換部3、エレキCAD設計値割出部4でそれぞれ得ら



れた結果値に基づいて、各PCBで使用しているクロック周波数の基本波、高調波の内て共振する波があるか否かの確認を行い、共振の可能性のある波の周波数については3m暗室での測定に合わせた電界強度の値として計算し、その値を製品簡易イメージ生成/描画部6へ出力する。

【0014】

【数1】

$$E = 6.3 \times 10^{-7} \times \frac{f \times i \times L}{R}$$

【0015】すなわち、上記電磁的影響情報取得手段によって求められた電磁的影響情報に基づいて上記電磁環境適合性を検討する部分に対する電磁環境適合性の検討に供する（高調波周波数の重複の有無、高調波周波数のレベル等）判断情報と上記電磁的影響情報が予め設定された基準値内に収まらないときの（部材の位置関係の変更の示唆、警告など）改善指針情報を求める電磁環境適合性判断情報・改善指針情報取得手段の機能を果たす。

【0016】（6）製品簡易イメージ生成/描画部  
製品簡易イメージ生成/描画部6では、以下の①～③に示す出力処理を実行する。

① エレキCAD設計値割出部4によって計算した各PCBで使用する基本波周波数に基づいて計算した高調波周波数が、それぞれの発生源毎に重複がないか否かを判断する。例えば、各々の高調波周波数とその周波数を中心として±120kHzの範囲（規格値）内に入っているか否かを判断する。上記判断で重複が検出された場合、それぞれの基本波がどの高調波で重なるかを表示し、その重複を回避させるための基本波のずらす範囲を同時に表示する。

② この構造物の3次元簡易イメージと上記生成された2次元展開イメージに基づいて各々の構成PCB、接続部材（ハーネス）毎に、その最も高いレベルを示す高調波周波数とそのレベルをPCB、接続部材毎に色分けをして表示する。また、構造物（例えば、機械）全体としての3m暗室測定結果として周波数軸での各周波数スペクトラムを表示する。

③ それらの結果を各PCBの配置、ハーネスなどのはい回し、長さ、接地方法、場所の変更に対してそれぞれの計算結果がリアルタイムに変更するように表示し、更に、所定の規格値以上にそのEMIレベルを表示した場合は、どの構成PCB、接続部材が問題なのであるかの判定を行って警告表示を行う。このようにして、ユーザ（設計者）は、上記警告表示内容に基づいて設計値を変更させることが可能になり、ファクシミリ装置、コピー機（複写機）、機械等の各種装置の設計効率を向上させることができる。すなわち、上記電磁環境適合性判断情報・改善指針情報取得手段によって求められた判断情報と改善指針情報とを出力する判断情報・改善指針情報出

力手段の機能を果たす。

【0017】図2及び図3は、図1に示したEMC実装設計支援システムにおける処理を示すフローチャート図である。このEMC実装設計支援システムの処理は、図2のステップ（図中「S」で示す）1で3次元メカCAD設計値抽出部が3次元CAD設計値からEMCを検討する各部分に関連する情報を取り込み、ステップ2で同じく3次元メカCAD設計値抽出部が部品間の相対位置情報、寸法値と座標データ等の大きさ情報、材質情報等

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【0018】その後、図3のステップ8で3次元/2次元変換・展開部が上述の処理を行い、ステップ9でエレキ設定パラメータ変換部が上述の電磁的要素情報抽出処理を行い、ステップ10でEMIレベル計算部が上述の処理を行い、ステップ11で製品簡易イメージ生成/描画部が上述の処理を行い、ステップ12でユーザによるパラメータ変更か否かを判断して、変更ならステップ14へ進んでPCBに対する変更か否かを判断し、メカ部品に対するパラメータの変更ならステップ8へ戻り、PCBに対するパラメータの変更なら図2のステップ6へ戻る。ステップ12の判断でパラメータ変更でなければステップ13へ進んで上述の処理で得られた値が規格値内に収まったか否かを判断して、この処理を終了する。

【0019】図4は上述の処理における構造物のEMCを検討する部分の一例を斜線を施して示す図であり、図5は上述の処理におけるPCB及びメカ部品の一例を斜線を施して示す図であり、図6は上述の処理におけるEMCを検討する各部品の3次元イメージから変換した2次元イメージの一例を示す図である。

【0020】

【発明の効果】以上説明してきたように、この発明の電磁環境適合性検討支援装置と電磁環境適合性検討支援方法とコンピュータ読み取り可能な記録媒体によれば、電子電気機器の設計時に構想設計段階からメカ系とエレキ系の設計者が同じ設計環境を使用して互いの設計意図やパラメータを共有できるので、設計内容の伝達のミスや漏れを無くすと共に、メカ系とエレキ系での互いのいろいろな制約条件が相手の設計パラメータにどのような影響を与えるかを定量的に検証することができ、トレードオフの設計条件が製品として最適なバランスになるように検討することもできる。したがって、電子電気機器の

試作の前段階で設計条件等の検討ができるので、試作後の設計変更を無くして無駄な経費の発生を抑えることができ、設計期間も短縮することができる。そして、設計期間の短縮によって新製品を素早く市場に投入することができる。

【図面の簡単な説明】

【図1】この発明の電磁環境適合性検討支援装置の一実施形態であるEMC実装設計支援システムの構成を示すブロック図である。

【図2】図1に示したEMC実装設計支援システムにおける処理を示すフローチャート図である。

【図3】図2に示した処理の続きを示すフローチャート図である。

【図4】図2及び図3に示した処理における構造物のE \*

\*MCを検討する部分の一例を斜線を施して示す図である。

【図5】図2及び図3に示した処理におけるPCB及びメカ部品の一例を斜線を施して示す図である。

【図6】図2及び図3に示した処理におけるEMCを検討する各部品の3次元イメージから変換した2次元イメージの一例を示す図である。

【符号の説明】

1：3次元メカCAD設計値抽出部

2：3次元/2次元変換・展開部

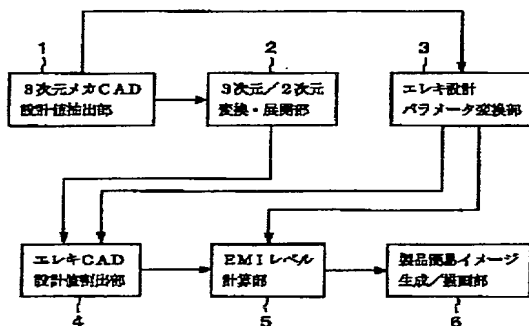
3：エレキ設計パラメータ変換部

4：エレキCAD設計値割出部

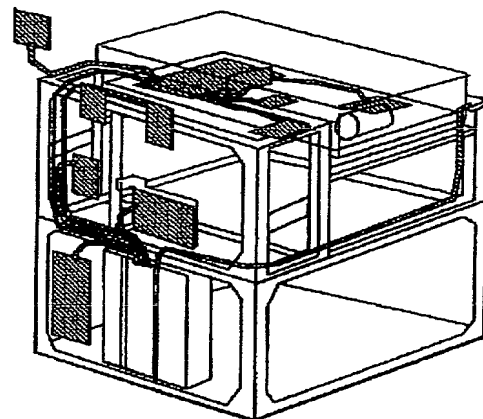
5：EMIレベル計算部

6：製品簡易イメージ生成/描画部

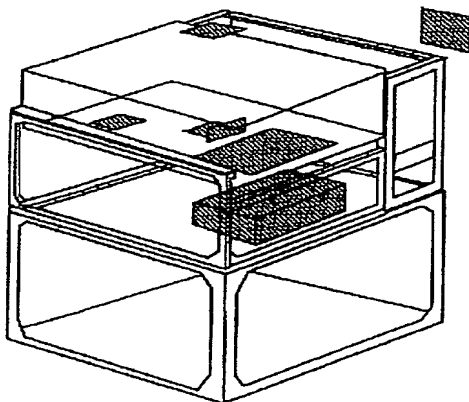
【図1】



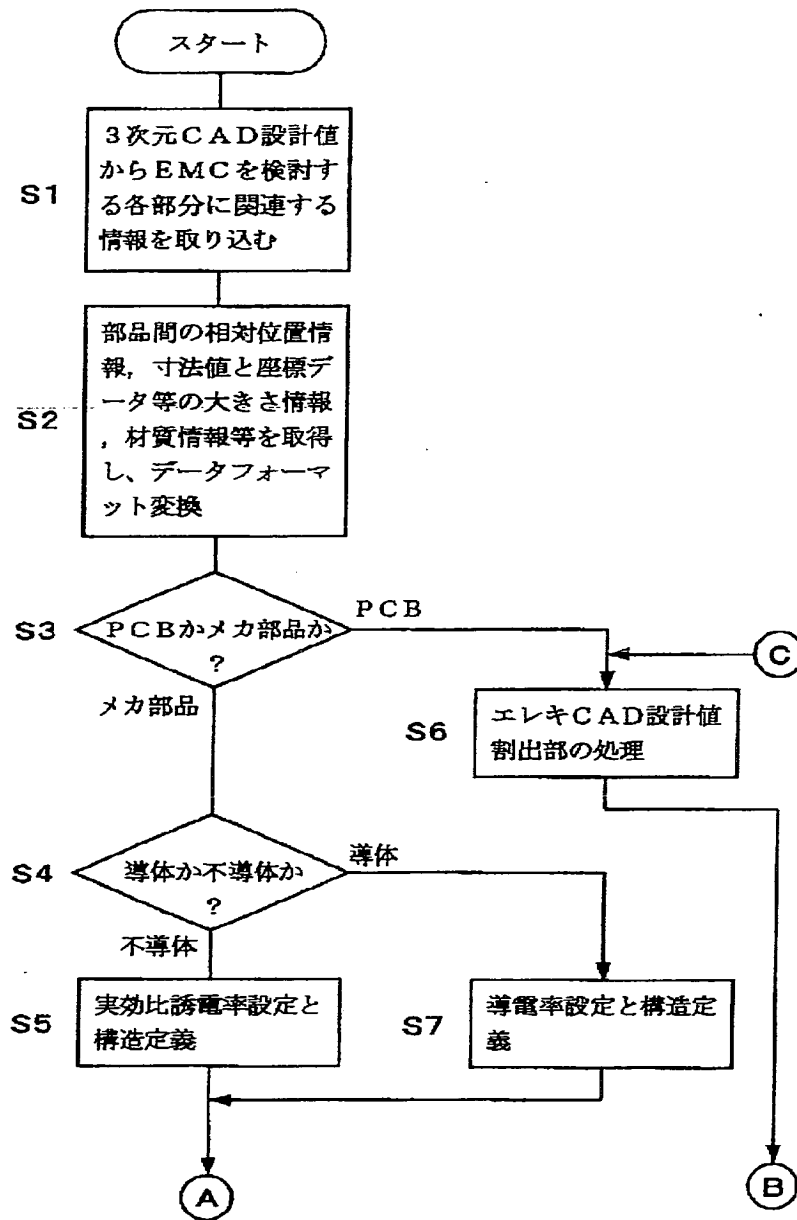
【図4】



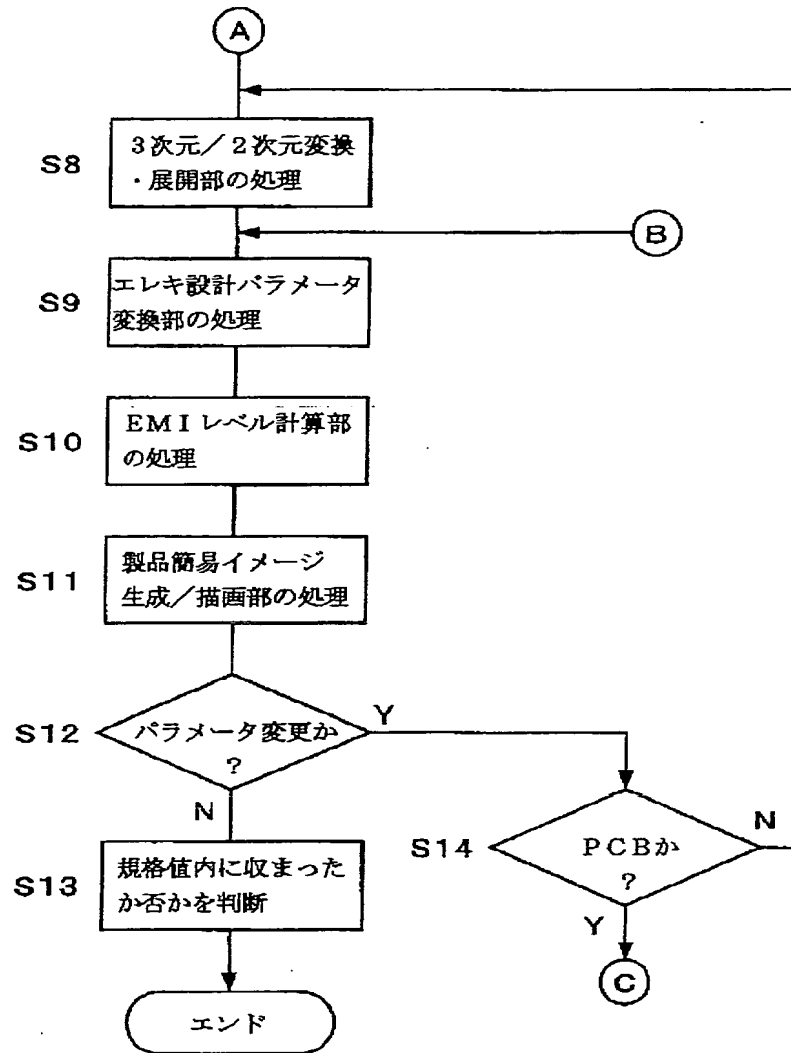
【図5】



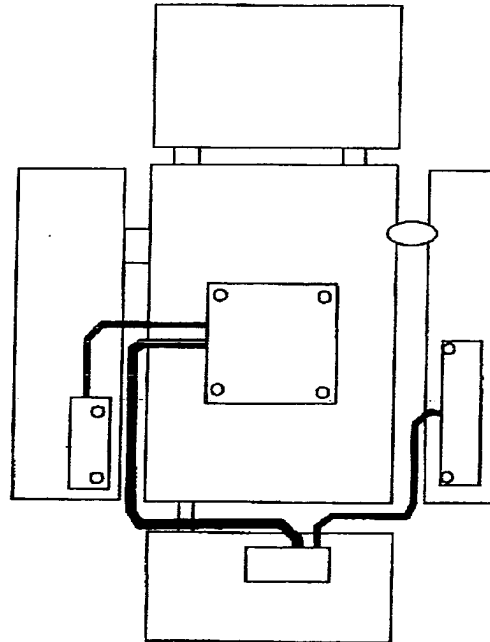
【図2】



【図3】



【図6】



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フロントページの続き

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